The estimation of the aftershocks that occurred on the mainshock fault from precisely determined focal mechanisms

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Utilizing the data of hypocenters and focal mechanisms of the aftershocks the 2000 Western Tottori Earthquake, Japan, which had been determined precisely, we tried to clarify whether aftershocks occur on or off the mainshock fault. And we tried to estimate the strength of fault around the hypocenter of the mainshock from the spatial distribution of the nodal planes near the hypocenter of the mainshock.

599 aftershocks were used in this study. We used the location data of aftershocks of Shibutani (2003). The relative horizontal errors of these aftershocks in the EW and NS direction and the depth errors of them are less than 100 m and less than 150 m, respectively. We used focal mechanisms determined by Katao et al (2002). We selected focal mechanisms of whitch the errors of the strike and dip of the nodal plane are less than about 5 degrees.

We assumed the strike, dip, length, width and position of the mainshock fault as a simple fault plane. And we found the aftershocks that have the nodal plane consistent with the strike and the dip of the mainshock fault to estimate aftershocks occurring on the mainshock fault. Among two possible nodal planes of focal mechanisms, we regarded the nodal plane having the azimuth closer to that of the mainshock fault as the fault plane of the aftershock. From the direction of the fault planes of the aftershocks, we found the aftershocks occurring on the mainshock fault plane based on following two conditions, the strike of the fault plane of aftershock is within +-10 of that of the mainshock fault and the dip of it is more than 70. We regarded the aftershocks that occurred within a certain distance from the mainshock fault and have the fault plane consistent with the strike and dip of it as occurring on the mainshock fault.

The number of aftershocks having the consistent fault planes of the mainshock fault that occurred within +-1 km from it is only 12 % of all aftershocks. It is found that almost all the aftershocks occurred within +-1 km from the mainshock fault, excluding the aftershocks that occurred in the northern part of the aftershock region. It is inferred from this result that the true fault plane located within +-1 km from the mainshock fault assumed in this study. We estimated the difference angle from the strike of the mainshock fault using the power spectrum of the trace of the San Andreas fault in Sholz and Aviles (1986). The difference angle is about 1 degree. We can regard the aftershocks that occurred within +-1 km from the mainshock and have the consistent fault plane of it as occurring on the mainshock fault. Thus this result indicates that more than 88 % of all the aftershocks occurred outside of the mainshock fault.

And moreover, we assumed another simple fault plane as the initial rupture fault near the hypocenter of the mainshock, because the focal mechanism of the initial rupture process is different from that of the main rupture process. We found the consistent fault planes of the initial rupture fault by same procedure.

Almost all these aftershocks aligned on the initial rupture fault in the area around the hypocenter of the mainshock, and aftershocks did not occur outside of the initial rupture fault around the hypocenter of the mainshock. If the strength of the initial rupture fault is much lower than that of any other planes existing near the hypocenter of the mainshock, the rupture occur on the initial rupture fault before stress on the pre-existing planes near the hypocenter exceed their strength. Thus, the results of the aftershock distribution near the hypocenter of the mainshock show that the strength of the initial rupture fault was much lower than that of any other planes existing near the hypocenter of the mainshock. From this result and the distribution of the aftershocks around the mainshock fault, it is inferred that the initial rupture fault was weaker than any other pre-existing plane including the mainshock fault.